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CONSUMPTION SMOOTHING AND VULNERABILITY IN THE ZONE LACUSTRE, MALI

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Abstract

This paper explores risk sharing in the Zone Lacustre, Mali, as viewed through the lens of consumption smoothing. We find that idiosyncratic shocks appear to have little impact on consumption, and that households respond to these shocks in a variety of ways. In general, nonpoor households are more likely to enter into new income-generating activities while poor households are more likely to engage in credit or gift exchange or to ration consumption. When we construct a stronger test for consumption smoothing, we find that changes in household income lead to modest changes in consumption. Covariant shocks, as measured by village/round dummies, always lead to changes in consumption. These results are robust to concerns regarding bias resulting from measurement error or endogeneity of changes in income. Lastly, we find that households with access to improved water control infrastructure are less vulnerable than those that rely on rainfall or the flooding of the Niger River.

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1. Introduction

Many people in developing countries are vulnerable to shocks that lead to reductions in well-being (World Bank 2000). The shocks may be idiosyncratic (affecting individuals or households) or covariant (affecting groups of households or communities, regions, or nations). Understanding the nature of this vulnerability and the informal or formal coping mechanisms that may mitigate shocks is a first step in establishing effective social protection programs.

This paper explores vulnerability issues through the lens of consumption smoothing. It asks which groups or individuals are unable to fully insure—or smooth—their consumption in the face of shocks to their income. Drawing on data from the Zone Lacustre in northern Mali, we show that in all cases, covariant shocks lead to changes in consumption. When we examine specific idiosyncratic shocks, we find that these appear to be fully insured against. We also consider a stronger test for consumption smoothing, namely the impact of changes in total household income on consumption with controls for idiosyncratic shocks. Here, however, the hypothesis of complete insurance is rejected.

We also explore vulnerability issues by disaggregating the sample along a number of characteristics. In a semiarid country such as Mali, which is heavily reliant on agriculture, one would expect that control over water would emerge as a key correlate of vulnerability. In the Zone Lacustre, this is indeed the case. Households with access to improved water-control infrastructure experience less variability in consumption than those that rely on rainfall or the flooding of the Niger River. Households whose occupational base is livestock or fishing, and those of ethnic minorities, appear to be more vulnerable, especially across food consumption.

2. Mali's Zone Lacustre

Mali is a landlocked country of approximately 12 million people in West Africa. Its 1.2 million square kilometers include three climatic zones: the semi-humid and dry savannah zones in the south, and the Sahara Desert in the north. One area of Mali judged to be particularly susceptible to income shocks is the Zone Lacustre. Situated in the remote northern region of the Niger River valley, it is characterized by subsistence agriculture. The area has suffered from deteriorating climatic conditions, poor infrastructure, and some of the poorest health and education attainments in the country. Our results are based on a four-round household survey conducted in 10 villages in this area.[1]

The Survey Area

The 10 villages in the survey area are centered around the small town of Niafunké located on the north bank of the Niger River. This area covers a roughly 90-by-30-kilometer stretch of the river and comprises low-lying areas, ponds, and lakes that are flooded by the Niger during rainy seasons. The area is 185 kilometers southeast of Tombouctou, the administrative and closest urban center, and it has two local market centers, Niafunké and Tonka, both on the Niger's banks, with populations of roughly 7,000 each.

The survey area is located within the Sahelian climatic zone and suffers from variable and increasingly limited rainfall levels. This trend toward aridity has been worsening over the past 20 years. The average rainfall over the period 1992–96 was 234 millimeters, down from the 1940–50 average of 276 millimeters. In 1997, the first year of our survey, there was only 172 millimeters of rain. The rise and fall of the Niger also affects the agricultural potential of the area, as rising waters flood areas for rice and millet cultivation. This irrigation mechanism has also been deteriorating in recent

[1] Luc Christiaensen, now at the World Bank, led the survey work, supported by John Hoddinott. A full description of the survey and survey area is found in Christiaensen (1999).

decades as river levels have lowered. River levels depend on the rains in the distant Guinean mountains, not local rainfall.

The rural areas surveyed are isolated and poorly accessible. Travel to and from the areas depends on watercraft in the rainy seasons and four-wheel drive in the hot dry seasons. Travel is always slow and costly, virtually isolating the area from surrounding markets. Travel is undertaken largely on foot or by donkey over paved or dirt roads, and by prau over the flooded waterways. The villages are, on average, 15 kilometers from the closest market center.

The population in the survey area was estimated in 1996 at 94,000. An overall population density of 29 inhabitants per square kilometer understates true density, as inhabitants are concentrated on arable lands. Population growth, despite high birth rates, is negligible due to high infant mortality and significant out-migration. While the out-migration has been found to follow the agricultural growing cycle, the worsening climatic conditions of the area have been exacerbating the phenomenon, and many men and families are leaving for longer periods or even permanently.

Education and health standards are below national levels. Illiteracy rates within the region remain at 70 percent for men and 90 percent for women, with only 60 percent of individuals experiencing some form of formal schooling. Fewer than 15 percent complete primary school. The area has benefited from efforts to install cleaner water supplies. Ninety percent of households use water from a well, but overall sanitation is poor.

The ethnic composition of the area is diverse: the majority Sonrhai account for 62 percent of the survey's households; Bambara accounts for 10 percent; Tamasheq, 4 percent; Peuhl, 23 percent; and Bozo, 1 percent. These groups traditionally engage in different economic activities. The Sonrhai and Bambara are traditionally agriculturalists; the Tamasheq and Peuhl, transhumant pastoralists; and the Bozo, migratory fishermen. These groups used to be organized along hierarchical lines; some were nobility, others slaves and various castes. Traditional social hierarchies exist in the area and affect the access to resources of some minority groups.

Villages take the form of nucleated settlements. Within villages, individuals live in dwellings or huts grouped together in a compound surrounded by a wall. One further distinguishes families that consist of several households linked by kinship. Following local practice, households were defined as consumption units or a collection of individuals eating from a common pot. These individuals recognized a common authority, the household head, and shared their incomes. Although household members usually lived together in the same dwelling or hut, this was not always the case. For example, it was not uncommon for brothers to live together—with their wives and children in separate dwellings within the same compound—while still sharing their meals and having their father as household head. These individuals constituted one household. Households typically consisted of parents and their children, and sometimes grandparents, brothers or sisters, and adopted children. Following local practice, polygamous households were counted as separate if each constituted a separate consumption unit and if the different women did not share their income and lived in separate dwellings.

The villages surveyed were within a one-hour driving distance of Niafunké. Two (Tomi and Ouaki) were located directly on the Niger River; three (Tomba, Aldianabangou, and Hamakoira), on the Dangha (a pond with water control infrastructure); three (N'goro, Mangourou, and Gouati), on the Koboro pond (which does not have infrastructure); and two (Anguira and Goundam Touskel) that rely largely on rainfall. These villages contain populations from each main ethnic group. Within these villages, there were three types of agriculture systems: rainfed, water recession, and irrigated. The trade-offs between the three types are yield uncertainty and the amounts of labor and investment required. To help reduce variable crop yields, the area has increasingly been the focus of development agency irrigation infrastructure projects. Millet, sorghum, and rice are the main crops.

The Survey

The first survey was fielded in August–September 1997, just prior to the harvest. This was followed by a second round during the postharvest period (November–December 1997); a third, in the quiet period between agricultural seasons (February–March 1998); and the fourth, during a second hungry period (August–September 1998). The need to include in the sample a variety of agricultural systems, together with the physical difficulties associated with moving within the area, dictated the sampling strategy chosen. A two-stage sampling procedure was used: (1) the purposive selection of 10 villages and (2) random selection of one-third of the households within each village, yielding a sample of 275 households.[2] These household survey data were supplemented by additional anthropometric surveys, participatory rural appraisal (PRA) work, and weekly market surveys.

Women and men within households were interviewed separately. The survey contained questions on household size and composition, agricultural production, sources and levels of nonagricultural incomes, assets, consumption, anthropometry, and health. Although "shock" indices, as found, for example, in Dercon and Krishnan (2000), cannot be constructed directly from these data, information on exogenous events, such as crop loss due to insect infestation, loss of labor time due to illness, and theft of livestock, are found in the household questionnaires. Table 1 shows, along with basic descriptive data for the sample, that such shocks are common. Approximately half the sample reports that crop production was affected by insect infestations, and labor time was lost as a result of illness. About a quarter of households report loss of livestock due to theft or death, or, for a variety of reasons, the inability to cultivate all land available. Households are not especially large by West African standards. Table 1 shows that mean and median values hover between 5 and 6, although the largest household exceeds 20 members. There is some reduction in household size over the sample, with the exception of the final survey round, when migrants returned to assist with the new harvest season. Also found is a

[2] The construction of the sample is described in Christiaensen, Hoddinott, and Bergeron (2001).

temporary attrition of whole households following the poor harvest in 1997. This was followed by their return in time to plant for the 1998 harvest.

Table 1—Means and standard deviations of household characteristics

		Villages			
	Whole sample	**With access to riverside irrigation: Tomi and Ouaki**	**On ponds with flooding control: Aldianabangou, Tomba, and Hamakoira**	**With access to ponds but no flooding control: Mangourou, Gouati, and N'goro**	**Reliant on rainfed agriculture: Goundam Touskel and Anguira**
Household characteristics					
Age of household head	52.43 (14.19)	50.28	54.93	51.60	53.60
Household size, Round 1	5.82 (3.60)	5.75	6.35	5.48	5.81
Changes in household size between rounds	-0.13 (1.34)	-0.04	-0.27	-0.08	-0.07
Female-headed	0.09 (0.29)	0.05	0.11	0.09	0.11
Asset nonpoor	0.40 (0.49)	0.57	0.20	0.36	0.57
Asset poor	0.60 (0.49)	0.42	0.79	0.63	0.42
Belongs to ethnic majority (Sonrhai)	0.61 (0.48)	0.62	0.90	0.51	0.28
Principal occupation self-defined as agriculture	0.67 (0.46)	0.68	0.70	0.70	0.52
Income shocks to household					
Value of livestock deaths	13,052.13 (48,026.4)	10,537.94	7,977.34	17,138.87	16,737.09
Crops affected by insect infestation	0.45 (0.49)	0.37	0.53	0.45	0.45
Lost productive time due to illness	0.49 (0.50)	0.53	0.52	0.44	0.46
Lost livestock to theft or death	0.47 (0.44)	0.18	0.26	0.35	0.27
Debt, net sales, and transfers					
Net debt (credit-loans)	1,751.089 (41,272.86)	3,920.898	-4,766.779	6,492.298	-1,394.205
Net livestock sales (sale-purchase)	8,874.124 (38,520.31)	7,446.615	19,262.37	4,210.438	8,916.239
Remittances received	23,667.01 (64,918.82)	14,763.43	33,227.00	23,606.18	19,606.54
Number of households (Number of observations)	275 (1,101)	64 (256)	74 (297)	99 (396)	38 (152)

Notes: Values in parentheses are standard deviations except for education, where the figure refers to the number of households with any schooling.

Considerable detail on the construction of income and consumption aggregates is found in Christiaensen (1999). Consumption consists of food expenditures (both purchased and the value of consumption of gifts and own production), nonfood expenditures, and gifts. Income is the sum of wage employment, net income from agriculture, net earnings from self-employment, and migrants' remittances and gifts. As Table 2 shows, incomes in the area are low, with median consumption hovering around US$16 or CFA[3] 9,627 per person per month. The mean figure of $19.30 per person per month is broadly consistent with national income accounts data that give a figure of annual GNP per capita of $240. Other data in the survey are consistent with these low magnitudes. For example, average asset values (tools and livestock) were approximately $100 per person in August 1997, with men holding 70 percent of household assets. Apparent in Table 2 is a slight decrease, rather than an increase, following the poor harvest in October–November 1997. Also, there is clear evidence that households try to protect food consumption across seasons. Median food consumption varies by less than 5 percent across seasons. By contrast, nonfood consumption is considerably more volatile. Reported incomes (Christiaensen 1999) follow a similar seasonal pattern.

Table 2—Mean and median per capita consumption, by survey round

	August-September 1997		November-December 1997		February-March 1998		August-September 1998	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Per capita consumption, food and nonfood	11,243	9,672	10,265	8,504	10,524	9,030	10,019	9,362
Per capita food consumption	8,575 (76.3)	7,336	8,497 (82.8)	7,297	8,204 (78.0)	7,361	7,965 (79.5)	7,568
Per capita nonfood consumption	2,366 (21.0)	1,556	1,420 (13.8)	759	1,841 (17.5)	847	1,599 (16.0)	1,008
Per capita gifts received	303 (2.7)	107	347 (3.4)	1	478 (4.5)	12	454 (4.5)	208

Notes: All figures are monthly per capita amounts in CFA francs. Percentages of total consumption are denoted in parentheses. August-September 1997 and 1998 are hungry periods just prior to harvest. November-December 1997 is the postharvest period. February-March 1998 is the quiet agricultural period between postharvest and hungry period.

Although most (70 percent) households report their principal occupation as agriculturalists, sources of income are diverse. Table 3 enumerates the percentage of

[3] Francs issued by the African Financial Community (Communauté Financière Africaine).

households reporting income from sources other than crops. These activities are concentrated in service and artisanal activities and vary by season. Also important at various times are transfers in the form of food and nonfood goods.

Table 3—Household income diversification: Percentage of households reporting noncrop incomes

	August-September 1997	November-December 1997	February-March 1998	August-September 1998
		(percent)		
Agricultural labor	5.1	7.3	4.7	2.2
Livestock	9.5	3.6	1.1	1.5
Fishing	2.9	1.5	1.8	0.0
Artisan	80.4	63.4	55.9	70.6
Petty trade	30.2	11.2	6.1	10.9
Nonagricultural labor	9.8	4.7	5.4	4.7
Services	48.7	35.9	10.1	36.0
Forestry	1.5	0.36	1.8	3.3
Food gifts from family, friends	16.6	12.7	11.6	19.3
Nonfood gifts from family, friends	15.3	24.6	19.1	37.1

Notes: Activities used by a negligible percentage of households were state employment, interest on loans, brick making, inheritance, collective funds, wild foods, *bourgou*, rent of equipment, rent of house, and income from pensions.

3. Testing for Consumption Smoothing

Overview

Tests of consumption smoothing arise from the assumption that households attempt to spread the consumption of their lifetime earnings evenly across time, through the use of mechanisms that reduce or mitigate income shocks, or those that help them cope with the effects of such shocks. How much of lifetime income households choose to consume today relative to tomorrow is determined by individual preference, but the important point is that their income today bears only on today's consumption level through its contribution to permanent income. Temporary shocks to income today, in situations where there are insufficient smoothing mechanisms, should not affect current levels of consumption (Townsend 1995).

Although developing economies have largely been characterized as having incomplete or absent markets for most goods and services, it has been found that this is

not the case with consumption smoothing mechanisms (Townsend 1995). Indeed, households in these areas have created a variety of informal mechanisms to help them reduce, mitigate, or cope with the risks they continually face (Morduch 1999; World Bank 2000). Two factors differentially affect a given household's ability to smooth consumption and mitigate vulnerability. The types of risks experienced and the types of smoothing mechanisms (or, more accurately, their accessibility within the community overall) affect the degree of consumption smoothing that can be achieved.

Consumption smoothing mechanisms insure consumption levels against shocks to income. But, as with all insurance, the condition of the insurance group vis-à-vis the shocks experienced determines the extent to which the shock can be smoothed or insured against (Townsend 1995). If the shock is common across group members, then it is covariate and cannot be insured or smoothed out by those within the group. If everyone within the insurance group experiences a negative shock, the welfare of the group as a whole will diminish, because no one household experienced gains that could be shared. Idiosyncratic (individually experienced) shocks such as illness or death can be smoothed, however, through mechanisms that allow households to rely on others to share the repercussions of such shocks. Therefore, the breadth of the insurance group one can draw on to insure and smooth consumption, and the type of shock experienced, affect the extent to which consumption can be smoothed.

The extent of consumption smoothing achieved within a community can be tested by regressing changes in individual household income against changes in individual consumption, while controlling for the effects of covariate shocks. In situations of perfect consumption smoothing, the coefficient on changes in income will be zero (Morduch 1999). One can also examine the relative effect specific income shocks have on consumption within an area by testing what effect their occurrence has on consumption (Skoufias 2002). Using these methods, one can explore the implications specific shocks have on consumption and the extent to which households can smooth consumption and mitigate their vulnerability.

A second factor that affects a household's ability to smooth consumption is its characteristics and whether they allow for access to the mechanisms available within a community or insurance group. While, on aggregate, a community may have developed sufficient mechanisms and be effectively smoothing consumption, there may be segments of the community excluded from participating, and they may therefore be vulnerable. Exploring differences in household characteristics and characteristics of the particular coping mechanisms employed helps reveal the true extent of consumption smoothing of a region. Discovering who is the most vulnerable within a community by examining the abilities of groups to smooth their consumption relative to each other could help governments and donors ensure that adequate coverage within the community occurs.

Accordingly, we present our empirical results in four stages. We first explore whether households can insure against specific idiosyncratic shocks such as livestock loss or illness. We then explore how households protect consumption against these shocks by examining the coping mechanisms they employ. We then examine whether all idiosyncratic shocks, as represented by changes in total incomes, affect consumption. Finally, after consideration of some econometric issues, we explore which groups are relatively more vulnerable—in a consumption smoothing sense—as a result of changes in income.

Basic Findings

To determine whether consumption is affected by specific idiosyncratic shocks, we estimated the following model:

$$\Delta \ln c_{hty} = \Sigma\theta_{tv}(VD_{tv} + \beta S_{htv} + \lambda X_{htv} + \Delta e_{htv}, \qquad (1)$$

where $\Delta \ln c_{htv}$ denotes changes in log per capita consumption as defined in Section 4; VD_{tv} is a vector of village dummies interacted by survey round to capture all common shocks at the village level; S_{htv} is a set of dummy variables indicating the occurrence of an idiosyncratic household shock; X_{htv} is a vector of time-varying household

characteristics[4]; θ_{tv} , β, and λ are parameters to be estimated; and Δe_{htv} is the household-specific error term.

Results of estimating equation (1) are reported in Table 4.[5] We use four representations for shocks: whether crops were lost to insect infestation, whether the household was unable to cultivate all land available to it, whether livestock were lost due to theft or death, and whether at least one member of the household was unable to participate in economically productive activities because of illness.[6] We start with a simple specification in which only these idiosyncratic shocks appear.[7] Results are reported in column 1 of Table 4. We gradually relax this restriction by sequentially entering the representation of village common shocks (column 2) and household characteristics (columns 3 and 4).

When entered without other covariates, shocks to crops and livestock appear to have a negative effect on consumption. The incidence of crops being attacked by insects resulted in a 10 percent drop in total consumption. These results change once we control for common shocks in columns 2–4. The θ_{tv} are statistically significant, as shown by the F statistics reported by round for these village dummy variables, indicating that covariant shocks explain variations in consumption over time. That these income shocks cannot be smoothed highlights an important source of vulnerability for people living in the Zone

[4] In addition to the covariates reported in Tables 4–6, as part of our preliminary work, we also included ethnicity, occupation, and location interacted with rank of village in terms of per capita consumption. Inclusion of these characteristics does not affect the results reported here.

[5] Standard errors are corrected for heteroskedasticity using the methods outlined by Huber (1967) and White (1980).

[6] In preliminary work, we experimented extensively with the specification of these idiosyncratic shock variables. Representations that we tried, but found not to have a statistically significant impact on change in log consumption, included any member of the household being inactive for at least a short duration, due to illness; primary male or female of the household inactive for at least a short duration due to illness; primary male or female of the household inactive for at least one long duration due to illness; primary male or female of the household inactive for many periods of long duration; land not cultivated because of lack of rain, lack of flooding, shortages of labor, seeds, or capital; crops moderately or severely attacked by predators; continuous representations of land not cultivated; continuous representations of crops attacked by predators; loss of more than 10 percent of value of livestock; and continuous representation of livestock loss.

[7] This is equivalent to imposing the restriction that θ_{tv} and λ equal zero.

Lacustre. Shocks to crops no longer have a statistically significant impact on changes in total consumption, health shocks have no statistically significant impact, and livestock shocks have a small, rather poorly measured effect.

Table 4—Least squares determinants of change in total per capita consumption

	(1)	(2)	(3)	(4)
	Income shocks	**Idiosyncratic and village common shocks**	**Idiosyncratic and common shocks and socioeconomic characteristics**	**Household fixed effects regression**
Income shocks				
Crops were attacked by insects	-0.113**	-0.078	-0.077	-0.115
	(1.99)	(1.14)	(1.09)	(1.12)
At least one member of household lost productive time due to illness	0.025	0.079	0.063	0.069
	(0.48)	(1.46)	(1.22)	(0.93)
Lost livestock due to theft or death	-0.076	-0.091	-0.103*	-0.097
	(1.31)	(1.44)	(1.72)	(1.10)
Land cultivated less than land available	0.085	0.002	0.005	0.008
	(1.33)	(0.04)	(0.08)	(0.10)
Village dummies interacted with round (F-test)				
August 1997 to November 1997		5.30**	2.89**	
November 1997 to February-March 1998		3.29**	3.97**	
February-March 1998 to August-September 1998		6.32**	5.68**	
Socioeconomic characteristics				
Female-headed household			0.039	-
			(0.46)	
Change in household size			-0.061**	-0.036
			(2.93)	(1.54)
Household in top two quintiles of consumption expenditure			0.460**	0.891**
			(8.09)	(10.56)
Age of household head			0.001	-
			(0.95)	
Membership in dominant ethnic group (Sonrhai)			0.009	-
			(0.16)	
F-statistic	1.31	4.35**	7.27**	7.35**

Notes: Dependent variable is change in log per capita consumption (food, nonfood, and value of gifts received) between rounds. Sample size is 718. * = Significant at the 10 percent level, ** = significant at the 5 percent level. Absolute value of t-statistics is in parentheses. Standard errors are corrected for heteroscedasticity using Huber-White method.

The key finding reported in Table 4—and bearing in mind the additional results reported in footnote 6—is that these specified idiosyncratic shocks have little significant impact on consumption in the Zone Lacustre. By contrast, covariate shocks appear to be very important in explaining fluctuations in consumption.

Income Risk and Household Coping Mechanisms

As these specific idiosyncratic income shocks appear to have little effect on consumption, we now explore the ways in which households react to these events. To do this, we estimate a model similar to that of equation (1), whereby the effect that an income shock has on the probability that a household will engage in a particular coping strategy is tested. We construct a series of binary variables signifying whether the household reported, or was shown to undertake, a particular coping strategy during that period. We estimate whether experiencing an income shock increased the likelihood that these households pursued these strategies using a fixed effects logit model of the form:

$$\Pr ob(Y_{htv} = 1) = \frac{\exp(\mu_h + \beta S_{htv} + \gamma X_{htv})}{1 - \exp(\mu_h + \beta S_{htv} + \gamma X_{htv})} \quad . \tag{2}$$

This model allows for the role of household-specific, time-invariant observed and unobserved factors to be taken account of. Here the dependent variable is used to denote use of any of a variety of coping strategies related to migration, remittances, livestock sales, credit, aid from relatives or the state, income diversification, and food consumption composition changes.[8] The term μ_h represents all household-specific, time-invariant observed and unobserved factors. S_{htv} is a vector denoting the occurrence of the four income shocks discussed above, and X_{htv} is a vector to control for household time-varying characteristics such as age and gender composition of the household, survey round, and household size. Separate fixed-effects regressions were run for each of the dependent variables. Using equation (2), households whose value of Y_{htv} did not vary across rounds were dropped from the estimation. Where a shock has no explanatory power for why the household adopted the coping strategy, we would expect β to be zero.

Table 5 shows that no single coping strategy was used by households in response to income shocks; rather, a portfolio of strategies was employed. Further, households

[8] Strategies related to the sale of possessions were also examined with no significant results found.

coped with income shocks not only through traditionally defined coping mechanisms (such as credit and gift giving), but also by adjusting their income generation across activities and making changes in the composition of their consumption.

Table 5 reports the effect each shock has on the likelihood of a household adopting a response to an idiosyncratic shock for the full sample and for a disaggregated sample of asset-poor and asset-nonpoor households.[9] A loss of crops due to insect infestation increases the probability that the household reports positive net debt and out-migration as a survival strategy. When examining this shock across wealth classifications, it is found that asset-poor households are more likely to receive remittances. Both groups were significantly more likely to use credit because of this shock.

Households that experience idiosyncratic income shocks related to illness are less likely to use credit. Asset-poor households are less likely to receive nonfood gifts from friends and relatives as a result of this shock.

A shock caused by loss of livestock in general increases the likelihood that households engage in credit and had household members out-migrate since the last survey. This shock also increases the likelihood of the sample as a whole to have positive net livestock sales and report food aid from friends or family. Further examination of this shock across asset-nonpoor and asset-poor households shows that only asset-poor households are more likely to have members out-migrate, use credit, and report food gifts from friends and relatives. Both asset-nonpoor and asset-poor households are more likely to use livestock sales as a means of coping as a result of this shock.

Finally, both nonpoor and poor households unable to cultivate all of their landholdings were less likely to have members who out-migrated over the last period.

[9] Asset-poor households have livestock holdings as of August 1997 in the bottom three quintiles. Asset-nonpoor households have livestock holdings in the top two quintiles.

Table 5—Household fixed effects logit estimates of household coping responses to idiosyncratic shocks

	Income shock				
Household action	**Lost crops due to insect infestation**	**At least one member of household lost productive time due to illness**	**Lost livestock due to theft or death**	**Land cultivated less than land available**	**Number of groups**
Migration					
Household reports out-migration as a coping strategy	4.241**	-1.513	-0.623	-1.133	19
	(2.15)	(1.32)	(0.42)	(1.02)	
Household had members out-migrate since the last interview	0.083	-0.037	0.673**	-0.805**	163
	(0.25)	(0.14)	(2.15)	(2.45)	
Asset nonpoor	-0.246	0.323	0.732	-1.299**	66
	(0.39)	(0.62)	(1.33)	(2.12)	
Asset poor	0.117	-0.123	0.685*	-0.765*	97
	(0.27)	(0.35)	(1.71)	(1.79)	
Remittances					
Household received positive remittances since last survey	0.268	0.135	-0.332	0.326	127
	(0.70)	(0.42)	(0.94)	(0.92)	
Asset nonpoor	-0.676	-0.196	-0.660	-0.435	50
	(1.04)	(0.30)	(1.09)	(0.64)	
Asset poor	1.007*	0.339	-0.538	0.877*	77
	(1.90)	(0.83)	(1.10)	(1.85)	
Livestock sales					
Household reports sale of livestock as a coping strategy since last survey	-0.523	-0.488	-0.794	0.185	33
	(0.76)	(0.78)	(1.44)	(0.28)	
Household had positive livestock sales since the last survey	0.272	-0.194	1.102**	0.174	109
	(0.83)	(0.73)	(3.57)	(0.55)	
Asset nonpoor	0.260	-0.429	0.772*	-0.377	51
	(0.48)	(1.06)	(1.81)	(0.77)	
Asset poor	0.213	0.095	1.629**	0.846*	58
	(0.48)	(0.25)	(3.18)	(1.77)	
Credit					
Household had positive net debt over the last survey period	1.577**	-0.679**	1.128**	-0.006	240
	(5.76)	(3.06)	(4.24)	(0.03)	
Asset nonpoor	2.380**	-0.544	0.623	0.055	97
	(4.98)	(1.43)	(1.58)	(0.14)	
Asset poor	1.085**	-0.852**	1.784**	-0.121	143
	(2.94)	(2.96)	(4.57)	(0.35)	
Aid from family, friends					
Household reports use of food gifts from friends and relatives as a source of income	0.554	0.157	1.078**	0.329	74
	(1.40)	(0.44)	(2.69)	(0.90)	
Asset nonpoor	0.969	-0.005	0.727	-0.609	31
	(1.50)	(0.01)	(1.18)	(1.06)	
Asset poor	0.413	0.313	1.762**	1.183**	43
	(0.72)	(0.54)	(2.42)	(2.13)	
Household reports nonfood gifts from friends and relatives as a source of income	0.168	-0.112	-0.185	0.568*	120
	(0.54)	(0.42)	(0.60)	(1.94)	
Asset nonpoor	0.097	0.651	-0.082	0.933*	50
	(0.20)	(1.52)	(0.19)	(1.94)	
Asset poor	0.439	-0.847**	-0.069	0.394	70
	(0.97)	(2.17)	(0.15)	(1.01)	

Notes: Additional regressors included but not reported include time varying regressors: household size, age composition of household, gender composition of household, and survey round. Z-value reported in brackets. * denotes confidence at the 10 percent level; ** denotes confidence at the 5 percent level.

Asset-poor households, however, were more likely to receive positive remittances, have positive net sales of livestock, and report food gifts from friends and relatives. Asset-nonpoor households had an increased probability of having received nonfood gifts.

There appears to be a variety of traditional coping mechanisms available to these households to cope with the shocks they experience. Households do not rely on a single mechanism, but cope with different shocks using different strategies. Asset-poor households were more likely to use out-migration of members, remittances, and food gifts from friends and relatives. Both asset-nonpoor and asset-poor households use livestock sales and credit.

In addition, Table 6 explores whether shocks induced households to enter into noncrop activities or alter consumption behavior, again disaggregating the sample into poor and nonpoor households. Generally, asset-nonpoor households are more likely to enter into new activities as a response to income shocks.[10] Crop loss increased the likelihood that nonpoor households' reported income from service jobs. Illness-related shocks increased the likelihood of earning income through off-farm agricultural labor, but decreased the likelihood of earning from artisan activities. The predominance of female participation in this activity, the effect that others' illness would have on the household workload of the female, and their own illness decreasing their ability to participate in activities outside of their traditional household duties would be consistent with this finding. Livestock losses increased the likelihood of the nonpoor to undertake artisan and service employment. Service employment also saw more participation from the income shock inability to cultivate land. Meanwhile, asset-poor households were more likely to undertake service-related activities as a result of crop and livestock losses respectively. This use of ex post income diversification as a coping strategy by nonpoor households

[10] This relationship between adjustments in income as a result of income shocks suggests some endogeneity in income changes, an issue we address in a later section.

Table 6—Household fixed effects logit estimates of household income and consumption responses to idiosyncratic shocks

	Income shock				
Household income or consumption response	**Lost crops due to insect infestation**	**At least one member of household lost productive time due to illness**	**Lost livestock due to theft or death**	**Land cultivated less than land available**	**Number of groups**
Income diversification					
Household reports income from activities not own agriculture	0.717*	0.024	0.806*	-0.037	66
	(1.71)	(0.07)	(1.67)	(0.09)	
Asset nonpoor	1.475*	-0.564	0.502	-0.259	28
	(1.96)	(0.95)	(0.71)	(0.33)	
Asset poor	0.324	0.439	1.065	0.271	38
	(0.59)	(0.91)	(1.40)	(0.49)	
Household reports agricultural labor as a source of income	-0.320	1.762**	-0.027	-0.207	36
	(0.05)	(2.65)	(0.05)	(0.27)	
Asset nonpoor	1.413	2.995*	-0.677	-0.607	17
	(1.13)	(1.77)	(0.66)	(0.47)	
Asset poor	-4.273*	2.066	2.725	-0.819	19
	(1.79)	(1.33)	(1.42)	(0.28)	
Household reports artisan activities as a source of income	-0.114	-0.667**	0.671**	0.370	117
	(0.38)	(2.45)	(2.04)	(1.18)	
Asset nonpoor	-0.025	-0.817*	1.073**	0.449	54
	(0.05)	(1.83)1	(2.29)	(0.90)	
Asset poor	-0.145	-0.571	0.083	0.277	63
	(0.34)	(1.58)	(0.17)	(0.66)	
Household reports income from service activities	0.496*	-0.176	0.796**	0.810**	126
	(1.77)	(0.70)	(2.70)	(2.78)	
Asset nonpoor	1.330**	0.161	1.586**	1.446**	47
	(2.16)	(0.32)	(2.68)	(2.70)	
Asset poor	0.117	-0.243	0.722*	0.492	79
	(0.33)	(0.79)	(1.75)	(1.31)	
Food consumption					
Served less preferred foods once in last week	0.636**	-0.387	0.314	-0.108	113
	(2.21)	(1.50)	(1.02)	(0.36)	
Asset nonpoor	0.316	-0.520	0.734*	0.209	55
	(0.75)	(1.29)	(1.70)	(0.48)	
Asset poor	1.126**	-0.236	-0.603	-0.274	58
	(2.54)	(0.65)	(1.19)	(0.63)	
Served less preferred foods more than five times in last week	0.241	0.541*	0.081	-0.482	86
	(0.60)	(1.75)	(0.23)	(1.43)	
Asset nonpoor	0.827	0.991	0.219	-0.962	29
	(1.23)	(1.61)	(0.43)	(1.64)	
Asset poor	-0.114	0.662*	0.109	-0.078	57
	(0.22)	(1.67)	(0.22)	(0.18)	
Served less food to men in last week once	0.766**	0.164	0.208	-0.661**	158
	(2.88)	(0.74)	(0.76)	(2.44)	
Asset nonpoor	0.285	0.048	0.503	-0.547	64
	(0.73)	(0.14)	(1.36)	(1.32)	
Asset poor	1.295**	0.279	-0.205	-0.668*	94
	(3.18)	(0.93)	(0.48)	(1.79)	
Served less food to men in last week two or three times	0.727**	0.301	0.278	-0.123	149
	(2.65)	(1.31)	(1.04)	(0.45)	
Asset nonpoor	0.684	0.035	0.445	-0.104	52
	(1.45)	(0.09)	(1.130	(0.23)	
Asset poor	0.877**	0.461	0.085	-0.109	97
	(2.39)	(1.57)	(0.22)	(0.30)	
Served less food to women in last week once	0.723**	0.167	0.672**	-0.574**	152
	(2.67)	(0.73)	(2.50)	(2.11)	
Asset nonpoor	0.116	-0.023	0.661*	-0.129	66
	(0.30)	(0.07)	(1.83)	(0.32)	

(continued)

Household income or consumption response	Income shock: Lost crops due to insect infestation	Income shock: At least one member of household lost productive time due to illness	Income shock: Lost livestock due to theft or death	Income shock: Land cultivated less than land available	Number of groups
Asset poor	1.527**	0.448	0.399	-0.865**	86
	(3.45)	(1.36)	(0.92)	(2.15)	
Served less food to children in last week two or three times	0.753**	0.041	-0.089	0.021	144
	(2.57)	(0.18)	(0.32)	(0.08)	
Asset nonpoor	0.512	-0.130	-0.016	-0.123	48
	(1.00)	(0.33)	(0.04)	(0.25)	
Asset poor	0.841**	0.117	-0.257	0.112	96
	(2.22)	(0.39)	(0.68)	(0.32)	
Household members missed meals in last week two or three times	0.471	0.855**	-0.061	0.800*	62
	(1.01)	(2.13)	(0.14)	(1.75)	
Household members missed food for a day in last week two or three times	0.087	1.814**	-0.293	1.039*	49
	(0.17)	(3.12)	(0.56)	(1.86)	

Notes: Additional regressors included but not reported include time varying regressors: household size, age composition of household, gender composition of household, and survey round. Z-value reported in brackets. * denotes confidence at the 10 percent level; ** denotes confidence at the 5 percent level.

contrasts with changes in food consumption by asset-poor households. Asset-poor households were more likely to ration food consumption, given these idiosyncratic shocks, or to switch to less-preferred foods.

Therefore, income diversification seems to be used relatively more by nonpoor households as a coping strategy across all income activities and shocks than it is for asset-poor households. While this result may highlight an inability for asset-poor households to diversify income sources, thereby signaling their increased vulnerability to income shocks in the longer term, this may not necessarily be the case in the Zone Lacustre. As shown in Table 3, a vast majority of households do report income generation across a variety of activities. Asset-nonpoor households are more likely to use these activities as a means for coping, while asset-poor households may diversify their activities across all periods or report income from a variety of activities, regardless of whether they experience a shock. It may be that asset-poor households are caught in a poverty trap whereby they, ex ante, diversify their incomes into activities that may not be an optimal allocation of labor as a means of insuring income. Asset nonpoor households use these income-generating activities as an ex post means to shift income generation. These nonpoor households, therefore, may be in a relatively better position to allocate

their labor toward the best risk/return activities in times of economic upturn and in a position of greater flexibility for times of economic downturn.

Households in the Zone Lacustre use a portfolio of coping strategies across income shocks. Coping strategies are complemented by income diversification activities by the nonpoor. Further, differences between the two wealth groups in their use of coping strategies highlights the relative vulnerability of the asset poor. This group may be unable to effectively access intratemporal consumption smoothing mechanisms, but it is relatively more likely to use remittances, outmigration, and food gifts from family. Thus, general income diversification is not only a coping strategy, but also a potentially inefficient form of insurance.

Further Tests of Consumption Smoothing

We now consider a stronger version of tests for consumption smoothing and the impact of changes in total household income on changes in consumption with controls for covariant shocks via inclusion of the VD_{tv} term. That is, we estimate

$$\Delta \ln c_{htv} = \Sigma\theta_{tv}(VD_{tv}) + \gamma\Delta \ln y_{htv} + \lambda X_{htv} + \Delta e_{htv} , \quad (3)$$

where $\Delta \ln y_{htv}$ is changes in log per capita income as defined in Section 4, γ is a parameter to be estimated, and all other variables and parameters retain the definitions given in equation (1). As Skoufias (2002) explains, under conditions of complete consumption smoothing, we would expect changes in income to have no effect on consumption. The coefficient on income changes, therefore, should be zero after controlling for covariate shocks.

Specification (1) reported in Table 7 shows that the coefficient, or elasticity of changes in consumption given income shocks, while statistically significant, was very close to zero at 0.076. However, this specification implies that positive and negative shocks are treated symmetrically; positive shocks are assumed to have the same impacts as negative shocks. This is a strong assumption; if one believed, for example, that it was

easier to save than to gain access to credit, such symmetry would not be expected.[11] Specification (2) takes this into account, including positive and negative income shocks as separate regressors. While the coefficients on positive income shocks are larger in magnitude, for both the full sample as well as a disaggregation by wealth, F tests do not reject the null hypothesis that positive and negative shocks have equal effects.

Table 7—The impact of changes in log household per capita income on log household per capita consumption

(Dependent variable: Change in log per capita household consumption)

	Parameter estimates			
	(1)	(2)		
Sample	**$\Delta \ln y_{htv}$**	**Positive $\Delta \ln y_{htv}$**	**Negative $\Delta \ln y_{htv}$**	**Sample size**
Full sample	0.076**	0.113**	0.046	591
	(4.30)	(3.61)	(1.43)	
Asset-nonpoor households	0.137**	0.155**	0.125*	221
	(3.94)	(2.82)	(1.85)	
Asset-poor households	0.038*	0.077	0.005	370
	(1.77)	(1.79)	(0.16)	

Notes: * = Significant at the 10 percent level, ** = significant at the 5 percent level. Absolute value of t-statistics is in parentheses. Standard errors are corrected for heteroscedasticity using Huber-White method. In specification (1), $\Delta \ln y_{htv}$ contains both positive and negative values; these are separated into two terms in specification (2). Values for F-test that positive and negative income shocks have statistically different impacts on change in consumption are: for the full sample, 1.56 (Prob value = 0.21); for asset nonpoor households, 0.09 (Prob value = 0.77); for asset-poor households, 1.32 (Prob value = 0.25). Asset nonpoor households are in the top two quintiles in terms of value of livestock holdings. Asset poor are those households in the bottom three quintiles. Additional regressors included but not reported are change in family size between Round t and Round $t-1$, whether the household is headed by a female, age of household head, age squared of household head, and a full set of community and round interaction dummy variables.

Partial Consumption Insurance

We now examine the extent to which partial consumption smoothing is occurring among households within the same village. Here we estimate the effects of changes in household and village average income against household consumption by estimating the equation

$$\Delta \ln c_{htv} = \alpha + \beta \Delta \ln y_{htv} + \gamma \Delta\left(\overline{\ln y_{tv}}\right) + \delta X_{htv} + \varepsilon_{htv} \ , \qquad (4)$$

[11] We thank Stefan Dercon for suggesting this example.

where $\Delta\left(\overline{\ln y_{tv}}\right)$ denotes the change or growth rate in average village income and all other variables are as previously defined. As Skoufias (2002) argues, where income shocks are not shared at all among community members, we would expect γ to equal zero. Where partial insurance occurs, $\gamma \neq 0$. Put another way, if all households were autarkic—in the sense of not engaging in credit or insurance transactions with each other—changes in consumption of any one household are independent of changes in the income of other households. This statement is equivalent to claiming that γ equals zero.

The top panel of Table 8 provides estimates of γ for all households and a disaggregation based on wealth. For the sample as a whole, there is some evidence of mutual insurance in the sense that a 10 percent increase in village mean income raises household consumption by 1.29 percent. When we disaggregate by wealth, we again observe that changes in village incomes appear slightly more relevant for the poorest households in this (generally poor) sample. These findings are consistent with a number of results reported in Table 5. In that table, we noted that poor households were more likely to receive aid from family or friends following an idiosyncratic shock. By contrast, nonpoor households were more autarkic in their behavior, relying more on entry into other income activities than on pooling risk with other community members.

Table 8 also examines whether positive and negative representations of covariate shocks have different impacts. These are reported in the lower panel of Table 8. As in Table 7, while the coefficients on positive income shocks are larger in magnitude, for both the full sample as well as a disaggregation by wealth, F tests do not reject the null hypothesis that positive and negative covariate shocks have equal effects.

Bias Concerns

It is worth considering whether the OLS estimates presented in Tables 7 and 8 are biased. Such bias could arise for several reasons. By itself, measurement error in right-hand-side variables generates “attenuation bias” that biases coefficients toward zero.

Table 8—Impact of change in log per capita income on change in log per capita consumption, controlling for change in mean log village income

(Dependent variable: Change in log per capita household consumption)

Sample	Specification (1)		
	γ estimates $(\Delta(\overline{\ln y_{tv}}))$	β estimates $(\Delta \ln y_{htv})$	Sample size
All households	0.129**	0.089**	591
	(2.98)	(5.03)	
Asset nonpoor households	0.112	0.139**	221
	(1.44)	(4.13)	
Asset-poor households	0.159**	0.061**	370
	(3.33)	(2.93)	

Sample	Specification (2)				
	γ estimates (Positive $\Delta(\overline{\ln y_{tv}})$)	γ estimates (Negative $\Delta(\overline{\ln y_{tv}})$)	β estimates (Positive $\Delta \ln y_{htv}$)	β estimates (Negative $\Delta \ln y_{htv}$)	Sample size
All households	0.221**	0.067	0.139**	0.043	591
	(2.69)	(0.80)	(4.33)	(1.44)	
Asset nonpoor households	0.248	0.045	0.178**	0.106	221
	(1.63)	(0.33)	(3.39)	(1.65)	
Asset-poor households	0.263**	0.075	0.117**	0.009	370
	(2.72)	(0.86)	(2.77)	(0.33)	

Notes: * = Significant at the 10 percent level, ** = significant at the 5 percent level. Absolute value of t-statistics is in parentheses. Standard errors are corrected for heteroscedasticity using Huber-White method. In specification (1), $\Delta \ln y_{htv}$ contains both positive and negative values; these are separated into two terms in specification (2). Values for F test that positive and negative income shocks have statistically different impacts on change in consumption are: for the full sample, 1.12 (Prob value = 0.29); for asset nonpoor households, 0.65 (Prob value = 0.42); for asset-poor households, 1.44 (Prob value = 0.23). Asset nonpoor households are in the top two quintiles in terms of value of livestock holdings. Asset poor are those households in the bottom three quintiles. Additional regressors included but not reported are change in family size between Round *t* and Round *t* – 1, whether the household is headed by a female, age of household head, age squared of household head, and a full set of round dummy variables.

But, as noted by Deaton (1997) and Skoufias (2002), it is possible that imputation errors in the construction of the food consumption variable may bias the income coefficients upward. A significant share of income and consumption is accounted for by food that is produced and consumed by the household and neither sold nor bought in the market. Any errors in imputing values to consumption may be positively correlated with measurement errors in the income variable, and for positive coefficients, this upward bias may work in the opposite direction to the standard downward attenuation bias produced

by the measurement errors in the income variable alone (Deaton 1997). Lastly, Tables 5 and 6 indicated that households undertake purposive actions—such as entering new income-generating activities—in response to shocks. Such activities affect incomes and render the change in log income variable endogenous.

The standard solution to both measurement error and endogeneity concerns is to estimate using two-stage least squares. The income shocks described earlier in the paper would, in principle, appear to serve as valid instruments. However, for us to be confident in such estimates, we need to be satisfied that our instruments are good predictors of our dependent variable and are uncorrelated with the dependent variable in our main regression. As Bound, Jaeger, and Baker (1995) note, poor instruments do not resolve these concerns.

Mindful of these considerations, Table 9 reports two sets of results. The top half of the table is based on a specification whereby the idiosyncratic shocks listed in Table 4 (crops were attacked by insects, at least one household member lost productive time due to illness, livestock was lost due to theft or death, land cultivated was less than land available) serve as instruments. Control variables include changes in household size, age

Table 9—Two-stage least squares estimates of the impact of changes in log household per capita income on log household per capita consumption

(Dependent variable: Change in log total per capita consumption)

Model 1	F test on "relevance" of instruments	Coefficient on change in log household per capita income	Overidentification test	Hausman test
2SLS estimates	0.58	0.396	0.60	3.22
		(1.29)		
OLS estimates		0.077**		
		(4.30)		
Model 2	**F test on "relevance" of instruments**	**Coefficient on change in log household per capita income**	**Durban-Watson-Hausman test**	**Hausman test**
2SLS estimates	5.52**	0.293**	0.70	3.12
		(2.77)		
OLS estimates		0.087**		
		(4.94)		

Notes: * = Significant at the 10 percent level, ** = significant at the 5 percent level. Absolute value of t-statistics is in parentheses. Standard errors are corrected for heteroscedasticity using Huber-White method. Model 1 uses shocks reported in Table 4 as instruments and includes (but does not report) as regressors: change in family size between Round t and Round $t - 1$, whether the household is headed by a female, age of household head, age squared of household head, and a full set of community and round interaction dummy variables. Model 2 uses changes in livestock holdings resulting from death or theft as instrument and includes (but does not report) as regressors: change in family size between Round t and Round $t - 1$, change in village mean income, and round dummies.

and sex of the household head, and a full set of community and round interaction terms. These shocks perform poorly as instruments, with an F value in the first-stage regression of 0.58—well below the minimum value reported in Bound, Jaeger, and Baker (1995). So, although these shocks pass the overidentification test outlined in Davidson and MacKinnon (1993), a Hausman (1978) specification test does not indicate any significant difference between these results and the OLS estimates. Because the explanatory power of these shocks is so poor, it is not clear that the top half of Table 9 addresses our bias concerns.

Given this difficulty, we searched through our set of idiosyncratic shock variables, looking for those that were strongly correlated with changes in income. We also amended our model specification to economize on degrees of freedom; control variables include only changes in household size, changes in village mean incomes, and round dummies. The value of livestock lost entered by itself proved to be the shock representation that produced the highest F statistic. Using the tabulations reported in Bound, Jaeger, and Baker (1995), a single instrument with an F statistic of 5.52 will produce a bias relative to the OLS results of less than 10 percent. The low value of the Durban-Watson-Hausman test indicates that it also passes the "uncorrelatedness" test. These results suggest that the OLS results are conservative estimates of the impact of income shocks to consumption with the coefficient on change in log household per capita income almost trebling when we move from OLS to 2SLS. However, a Hausman test does not reject a null hypothesis that the OLS and 2SLS estimates are equal.

Household Vulnerability by Socioeconomic Characteristic

Finally, we explore whether certain groups or villages within the Zone Lacustre are better able to smooth consumption relative to their reference groups in the face of idiosyncratic income shocks. We estimate

$$\Delta \ln c_{htv} = \sum_{tv} \theta_{tv}\left(D_{tv}\right) + \beta \Delta \ln y_{htv} + \gamma Z + \delta\left(Z * \Delta \ln y_{htv}\right) + \pi X_{htv} + \Delta \varepsilon_{htv} \ , \qquad (5)$$

where Z is a binary variable to identify those households possessing the characteristic of examination. The magnitude and sign of the δ coefficients indicate whether there is higher or lower covariation between income and consumption changes in the group of examination relative to its reference group.

Table 10 reports the results of estimating equation (5). Neither female-headed households, households with young children, households with young and old household heads, households with more than four members, households whose primary economic activities are focused around noncrop activities (e.g., pastoralists, fishers, and artisans), nor households who were not members of the dominant ethnic group experience greater variation in consumption, given income changes than their respective reference groups. However, recall that an important feature of Mali is that much of the country relies on highly variable rainfall. Also recall that the 10 villages surveyed were purposively chosen to reflect differing degrees of control over water supply for agriculture. We exploit this intervillage variation in Table 10. Here, the sample is divided into two groups, best and worst control over water supply. The villages with access to riverside irrigation infrastructure (Tomi and Ouaki) and on ponds, but with infrastructure that controlled flooding (Aldianabangou, Tomba, and Hamakoira), could smooth food consumption, but had some variations in nonfood consumption attributable to income changes. Villages on ponds but with no flood control (Mangourou, Gouati, and N'goro), and those practicing rainfed agriculture (Goundam, Touskel, and Anguira) experienced changes in total consumption and larger changes in nonfood consumption as shocks to income occurred.

4. Conclusions

This paper has explored vulnerability issues in the context of the Zone Lacustre, Mali, a poor region in one of the world's poorest countries, as viewed through the lens of consumption smoothing. Our principal findings are that individual idiosyncratic shocks appear to have little impact on consumption. Although there is no one single result, in

Table 10—The effect of idiosyncratic income shocks on consumption, by household characteristics

(Dependent variable: Change in log total per capita consumption)

Asset-nonpoor households (reference group)	0.139**
	(4.00)
Asset-poor households	-0.099**
	(2.22)
Households in villages with riverside or pond irrigation infrastructure	0.043*
	(1.80)
Households with no flooding control or reliant on rainfed agriculture	0.067*
	(1.90)
Male-headed households (reference group)	0.080**
	(4.08)
Female-headed households	-0.033
	(0.68)
Households with no members ages 0-6 (reference group)	0.063**
	(2.91)
Households with members ages 0-6	0.045
	(1.21)
Households whose head is over age 40 (reference group)	0.080**
	(3.90)
Households whose head is age 40 or less	-0.029
	(0.64)
Households whose head is under age 60 (reference group)	0.069**
	(2.89)
Households whose head is age 60 or older	0.015
	(0.35)
Household with more than four members (reference group)	0.086**
	(3.38)
Household with four or fewer memberes	-0.022
	(0.55)
Households whose main occupation in Round 1 is crop based (reference group)	0.072**
	(3.37)
Households whose main occupation in Round 1 is not crop related	0.015
	(0.38)
Household is a member of the Sonrhai ethnic group	0.070**
	(3.18)
Household is not a member of the Sonrhai ethnic group	0.017
	(0.51)

Notes: * = Significant at the 10 percent level, ** = significant at the 5 percent level. Absolute value of t-statistics is in parentheses. Standard errors are corrected for heteroscedasticity using Huber-White method. Additional regressors included but not reported are: change in family size between Round t and Round $t - 1$, a dummy variable denoting the specified socioeconomic characteristic, and a full set of community and round interaction dummy variables.

general, nonpoor households are more likely to enter into new income-generating activities given these shocks, while poor households are more likely to engage in credit or gift exchange or to ration consumption. A stronger test of consumption smoothing shows that—controlling for covariate shocks—changes in household income lead to modest changes in consumption. Covariant shocks, as measured by village/round dummies, are

shown always to lead to changes in consumption, although households with access to improved water-control infrastructure experience less consumption volatility than those that rely on rainfall or the flooding of the Niger River. Risk pooling over these covariant shocks, as measured by the relationship between changes in mean village incomes and household consumption, is a characteristic of poorer households. These results are robust to concerns regarding bias resulting from measurement error or endogeneity of changes in income.

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